AN EVALUATION OF PROBABLE BENEFITS AND COSTS

For The Proposed Rule to Establish the Columbia River Water Resources Management Program

Chapter 173-565 WAC

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EXECUTIVE SUMMARY

When proposing a new administrative rule for consideration, the Washington State Department of Ecology (Ecology) is required by 34.05.328(1)(d) RCW to determine whether the probable benefits exceed the probable costs. This document fulfills this requirement for the proposed Columbia River Mainstem Water Management Program (Chapter 173-565 WAC) rule and amendments to chapters 173-531A and 173-563 WAC. The intent of this analysis is to provide information necessary to assist the director of Ecology in making these determinations.

The proposed rule and amendments can be expected to affect agriculture, municipalities, industry, hydropower, flood control and navigation, recreation, fish population and fisheries. Based on information provided by the National Academy of Sciences (NAS), the University of Washington (UW), and other sources, this cost -benefit analysis quantifies the probable benefits and probable costs of the proposed rule. The analysis concludes that the probable benefits resulting from adoption of the proposed rule are $187.5 million greater than the probable costs, not including various un-quantified benefits.

Table of Contents

Evaluation of the Probable Benefits and Costs for the Proposed Columbia River Mainstem Water Management Program (Chapter 173-565 WAC)

1. INTRODUCTION

Competition for water from the Columbia River mainstem continues to grow. There are a large number of pending applications in Washington for new water rights from the river and the human population relying upon the river to support both personal and economic uses of water is also growing. At the same time, several salmon species have been listed as endangered and threatened. As a result, decisions related to out-of-stream water use has been controversial: caught between the need to consider environmental impacts, especially the impacts on salmon populations listed under the federal Endangered Species Act, and human demands for water.

Until recently the state has lacked its own scientific understanding of the effects of water use on salmon survival in the context of the mainstem of the Columbia. As a result, the state has struggled to define an appropriate program to support water resources decision-making affecting the river. A formal moratorium on the issuance of new water rights, and, a rule that required broad consultation with fisheries managers and local governments for each water right decision, proved to be unsustainable and unwieldy.

In this uncertain environment, the state has been challenged by stakeholders to make all or nothing decisions affecting the river's water resources. The Department of Ecology (Ecology) has twice been petitioned to initiate rule making for the Columbia River. The first petition sought to close the river and its tributaries in Washington to further appropriation. The second petition sought to require immediate processing of existing water right applications.

In light of these conflicting petitions and recognizing the scientific uncertainty that existed, Governor Locke chartered the Columbia River Initiative and challenged state agencies to develop a policy supporting the state's economic interests while protecting the health of the Columbia River ecosystem and the endangered salmon that depend upon it. The proposed rule implementing an integrated water management program for the Columbia River mainstem results from this direction from the Governor. The rule under consideration in this analysis is the product of a 3-year investment in scientific and economic analysis, and an extensive effort to involve stakeholders in framing state policy related to the river. The rule would implement policy legislation to be introduced for consideration by the 2005 Legislature.

In developing the rule proposal, Ecology sought the best available scientific and economic information and advice, as well as information supplied by the public. The state contracted with the National Academy of Sciences (NAS)/National Research Council for a review of the related scientific issues. The University of Washington (UW) was retained for a review of the economic issues associated with allocation of water from the river. These two studies provide the primary basis for this cost-benefit analysis.

Other sources of information are listed in footnotes and in the appendices provided at the end of this document.

Through the Columbia River Initiative, the state actively pursued the involvement of the many stakeholders with an interest in the future of the river, as well as the general public, in the process of developing the proposed rule. Comments and suggestions from people across the state were considered during the process of developing the proposed rule.

The analysis contained in this cost-benefit analysis will be used by the director of Ecology to make the following determination required in RCW 34.05.328(1)(d). The statute states that the director must:

> *Determine that the probable benefits of the rule are greater than its probable costs, taking into account both the qualitative and quantitative benefits and costs and the specific directives of the statute being implemented;*

The cost-benefit analysis evaluates whether or not the probable benefits of the proposed rule are greater than the probable costs. The analysis relies upon both qualitative and quantitative methods to reach a conclusion regarding the effect of the proposed rule.

2. BACKGROUND AND HISTORY

In Washington, the Department of Ecology administers the appropriation, distribution, and management of the state's waters. A water right is necessary for any diversion of water from surface and ground water. Washington Water Law is based on the doctrine of prior appropriation--"first in time, first in right". That is, an individual's right to a specific quantity of water depends on the effective date of the water right (also called the "priority date"). In times of shortage, senior water right holders, those with earlier priority dates, are entitled to have their water needs satisfied first.

Permit application procedures to use surface waters are set forth in Chapter 90.03 RCW, the 1917 State Water Code. Permit application procedures to use ground water are set forth in Chapter 90.44 RCW, the 1945 Ground Water Code. Ecology cannot issue a water right until the following findings are made:

1. The water is available;
2. The intended use is beneficial;
3. Issuance will not impair existing water rights; and,
4. The public interest will not be detrimentally affected.

A water right does not guarantee the availability of water. The degree of reliability depends on the seniority of the water right. Approved water rights may contain special provisions or conditions, including the protection of instream flows for certain purposes such as fish, wildlife, water quality, aesthetics, etc. At times of lower water availability the stream flow requirements may be enforced, thus limiting the availability of water.

In 1980, the state adopted an instream flow rule for the Columbia River designed to curtail water use in low water conditions. As a result, water rights along the mainstem of Columbia River issued after 1980 are subject to the state instream-flow rule (WAC 173-563-050). Under the instream flow rule, when the total amount of water flowing in the river at the Dalles Dam is forecasted to be below 60 million acre-feet between April and September, water users with permits issued after 1980 may be ordered to stop using water at certain times during that period.

Shortly following the 1991 listing of the Snake River sockeye salmon under the Endangered Species Act (ESA), the state established a moratorium on the issuance of new water rights from the Columbia and Snake Rivers so that fish needs could be further studied and appropriate instream flow standards could be established. On July 27, 1997, the moratorium was lifted in compliance with legislative direction, and revisions were made to Chapter 173-563 WAC. These revisions mandated that the instream flows established in 1980 would no longer be applied to new water rights applications, and further stated that:

> *Any water right application considered for approval or denial after that date [July 27, 1997] will be evaluated for possible impacts on fish and existing waters. The department [Ecology] will consult with appropriate local, state, and federal agencies and Indian tribes in making this evaluation. Any permit which is then approved for the use of such waters will be, if deemed necessary, subjected to instream flow protection or mitigation conditions determined on a case-by-case basis through the evaluation conducted with the agencies and tribes.*

Ecology is also required by law to consult with the Washington Department of Fish and Wildlife (WDFW) when reviewing water right applications. RCW 75.20.050 states that:

> *The director of Ecology may refuse to issue a permit if issuing the permit might result in lowering the flow of water in a stream below the flow necessary to adequately support food fish and game populations in the stream.*

As a matter of record, the 1997 rule revisions did not result in a stable decision-making environment. Ecology did not issue any new water right decisions affecting the Columbia River prior to 2003.

In October 2000, an irrigators' group filed a lawsuit against Ecology seeking a court order to require processing of pending water right applications. The lawsuit followed a series of negotiations between the irrigators' group and Ecology over the processing of Columbia River water rights applications. Prior to the conclusion of a trial, Ecology and the irrigators' group reached a settlement, which called for the processing of a limited number of water right applications that were pending prior to the adoption of the moratorium in 1991. The full terms of the settlement agreement are provided in Appendix G.

Subsequently, Ecology processed the following 10 water rights:

Applicant	**Total Water**	**Use**
Quad-Cities	178 cfs (96,619 AF)	municipal
Chelan Public Utility District (PUD) (2 rights)	9.78 cfs (7079 AF)	Fish hatchery
Kyle Mathison	88 ac-ft	reservoir
Steve Scheib	1.78 cfs (296 AF)	irrigation
Kennewick Irrigation District	82 cfs (22,610 AF)	irrigation
Kennewick Public Hospital District	49.5 cfs (13,951 AF)	municipal
Stemilt Irrigation District (2 rights)	7.1 cfs (1,739 AF)	irrigation
Mercer Ranches	0.016 cfs	irrigation

Of the 10 water rights processed in 2003, four permits were issued after no appeal was filed. These included the two Chelan PUD applications, the Kyle Mathison reservoir application, and the Steve Scheib application. The first three of these permits did not result in additional consumptive uses of water.

Of the remaining six permits, the Quad-Cities application was appealed by the Center for Environmental Law and Policy (CELP) and settled in the late summer of 2003. A permit with revised conditions was issued subsequent to the settlement. The remaining five permits are currently on appeal before the Court of Appeals in Spokane as a result of actions taken by the Yakama Nation, and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Nez Perce tribe.

Recent history shows that the probability of the state successfully issuing new water rights after 1991 is very low. Only 10 water rights from the Columbia River mainstem have been processed during this period, and the status of five of these is still uncertain as a result of continuing legal action. These legal proceedings may take years to reach resolution and the ultimate result of the litigation is uncertain.

3. OVERVIEW OF THE PROPOSED RULE

The proposed rule is designed to meet the water needs of growing communities and economies along the mainstem of the Columbia River, and to do so in a manner that protects and enhances the quality of the natural environment, including stream flows necessary for the preservation of environmental values.

Consistent with the pending CRI legislation, the state administration has proposed a set of actions necessary to implement a water efficiency and acquisition program that contributes water to the Columbia River mainstem in sufficient quantity to both meet the identified water supply needs of the Columbia Basin and reduce the risks that fish face over a 20 year period. These actions include the proposed rule covered by this analysis, capital and operating budget requests, and a set of negotiated water agreements with various partners.

The legislation requested by Governor Locke will establish the policy parameters underpinning the proposed Columbia River rule. To implement the water resources management program in a manner consistent with the requested legislation, the department would be required to:

(a) Acquire water prior to, and in mitigation for, decisions to authorize new uses of water from the Columbia River mainstem;
(b) Secure and deposit two-thirds of the acquired water into the mainstem account for allocation as mitigation water for new water uses through a state mitigation program;
(c) Secure and deposit one-third of the acquired water into the mainstem account for permanent allocation to improve stream flows; and,
(d) Authorize new uses of water from the Columbia River mainstem consistent with the requirements of the Program.

To establish an administrative framework consistent with the requested legislation, the proposed rule:

(a) Establishes the management guidelines for the Columbia River Mainstem Water Management Account (Account) under the State trust water rights program, chapter 90.42 RCW. The Account is a mechanism to manage water to mitigate for potential impacts from new uses of water from the Columbia River mainstem and to provide water for instream uses;
(b) Establishes an Administrator for the Account;
(c) Sets priorities for allocation of water from the Account;
(d) Establishes requirements and procedures for issuance of drought permits to complement existing interruptible rights on the Columbia River mainstem that are subject to the minimum instream flows set in WAC 173-563-040;
(e) Establishes requirements and procedures to secure a reliable supply of water for holders of water rights on the Columbia River mainstem issued in 2003 and for applications for new water rights to Columbia River mainstem surface waters that have been pending since 1991;
(f) Establishes requirements and procedures for issuance of new surface and ground water rights from the Columbia River mainstem for applications currently on file with the Department of Ecology (Department), and for any future water right applications affecting the Columbia River mainstem;
(g) Requires the department to contract with water right holders to partially offset the cost of acquiring mitigation water for the program.

In conjunction with the proposed Columbia River Mainstem Water Management Program rule, the Department will concurrently propose conforming amendments to Chapter 173-563 WAC and Chapter 173-531A**.** The existing instream flow rules and water use interruption requirements, and the existing water right application consultation process, will both be amended. Once amended, these current rule provisions will be applicable only to water right applications processed prior to the effective date of the new Columbia River rule.

These elements represent the core of the proposed rule, and as such, are the basis upon which the cost-benefit analysis is developed.

4. METHODOLOGY

In this section information is provided to give the reader a basic understanding of the methodology and assumptions used to develop this cost-benefit analysis.

The sections of the report dealing with social costs and benefits are written in a narrative form for a lay audience. Readers with an interest in more detailed and technical data and calculations should refer to the Appendices.

4.1 Measuring the costs and benefits

4.1.1

The costs and benefits measured in this analysis are social benefits and social costs. This is a standard methodology for developing cost benefit analyses. For illustrative purposes, this method of accounting would find no benefit to the state associated with a rule change that increased revenue from hydropower generation by $5 million if the associated environmental costs were estimated at $5 million. In other words, an action benefiting a particular party may not result in net social benefits. A finding of net social benefit means that the cumulative total of all costs and benefits to society is a positive value.

4.1.2

In a standard cost-benefit analysis, probable benefits are measured by gain in consumer surplus[1] or producer surplus[2], while probable costs are measured by the opportunity cost[3]. In some cases, measuring consumer surplus, producer surplus, and opportunity cost is impossible due to the limited availability of information or the uncertainty associated with a particular outcome. As a result, this analysis substitutes other approaches when necessary.

4.2 Time Horizon

In the following analysis probable benefits and probable costs are calculated for a 20-year period. This approach is used to dampen the effect that short-term variability can have on results associated with shorter time periods.

[1] This occurs when people are able to buy a good for less than they would be willing to pay. They enjoy more utility than they had to pay for.

[2] The difference between the minimum price a producer would accept to supply a given quantity of a good and the price actually received.

[3] The decision to produce or consume a product involves giving up another product. The real cost of an action is the next best alternative forgone.

4.3 Real Discount Rate

The calculations and results developed in this cost-benefit analysis are stated in real terms. This is accomplished by adjusting financial data for the effects of inflation in the future. For the purposes of this analysis the real discount rate (adjusted for inflation) is set at 2.45 percent.

4.4 Secondary Impacts Excluded

The economics report by University of Washington described regional and secondary impacts associated with the Columbia River Initiative. However, standard cost-benefit analyses do not incorporate secondary effects in their calculation of net social benefits. As a result, this analysis does not incorporate secondary economic impacts in its calculations. More information supporting this decision can be found in Appendix B.

4.5 Wealth Transfer and Fairness

Standard cost-benefit analyses do not analyze wealth transfers between entities or sectors. For example, under the proposed rule applicants for new water rights would be required to contract with the state to pay for a share of the cost of acquiring mitigation water. This transfer is a cost to applicants for water rights, but is also revenue to the state. Cost benefit analysis considers both the individual cost and the public benefits, and results in a finding that the sum of these particular costs and benefits are zero.

The analysis does not attempt to judge the fairness or appropriateness of wealth transfers that result from the proposed rule. This further analysis is outside the scope of standard cost benefit methods.

4.6 Baseline for Analysis

Standard cost-benefit analyses require a basis for comparing the current situation (described in section 2, above) to the situation expected to exist under the rule proposal. In order to accomplish this comparison, a baseline, or description of the current situation, must be defined. The baseline used in this analysis is:

> *No significant new water rights for out-of-stream water uses from the mainstem of the Columbia River are likely to be developed for the foreseeable future.*

For the purposes of analysis, this baseline reflects the state's post-1991 experience with attempts to issue water right decisions under existing rules and the litigation that has ensued. While a small probability remains that litigation may result in new water rights being issued in the future, the uncertainty associated with a legal remedy is significant enough, in the opinion of the state, to justify the use of this baseline.

4.7 Specific Projects to Implement Rule Not Considered

The analysis of the costs and benefits of specific water acquisition and resource development projects will be evaluated in the future on a case by case basis. For example, new off-channel, multipurpose storage projects will require federal partners, and as a result will be subject to full cost-benefit and environmental reviews consistent with federal law. Smaller scale projects funded by the state, or by the state in partnership with local governments, are subject to feasibility and cost reviews as a part of the state Capital Budget process.

This analysis focuses on the costs and benefits of the framework for decision-making provided by the rule, leaving the economic analysis of specific water projects to be evaluated on their own merits.

5. BENEFITS

5.1 Overview

Under the proposed rule, the state will create a program that authorizes new uses of water from the Columbia River mainstem in support of population growth and economic development. At the same time the program is designed to reduce the risks to fish by dedicating water to instream uses in ways that maximize environmental benefits. To achieve both human and environmental goals, Ecology will need to secure reliable sources of water.

The social benefits that would result from the adoption of the proposed rule are the increases in net revenue (profit) from the various new uses of water. Consistent with the stated methodology, a transfer of water from one out-of-stream use to another will result in a net benefit only if the transfer is from a lower value use to a higher value use.

The proposed rule, consistent with proposed legislation, would require that once water has been obtained, two thirds of the water will be obligated as mitigation for new water rights for out-of-stream uses, and one third of the water will be held for instream purposes. The social benefits of water provided for out-of-stream uses would result from various beneficial uses, such as, agricultural, and municipal and industrial uses. Beneficial uses would generate new production and income in Washington, and this is the social benefit that is quantified. Different beneficial uses would generate different social benefits.

The benefits generated as a result of the proposed rule are discussed in detail in sections 5.2 through 5.9 below.

5.2 Water for instream flow

The new rule proposes to reduce the risk to fish by improving stream flows in the Columbia River mainstem. The proposed rule would require one-third of the water obtained by the state to be held permanently in trust and remain instream. As a result of the proposed rule there would be more water in the Columbia River in the summer months of the year. According to the National Academy of Sciences, more water in the summer will benefit fish by lowering water temperatures, which is favorable to the migrating salmon smolts. More water in the river would also dilute pollution and improve water quality to some extent. Although there is not enough data available to quantify these benefits, a qualitative net benefit to Washington can be expected to result.

It is important to note that fisheries do have significant economic benefits to the State of Washington overall. For instance, it has been estimated that the total expenditures related to recreational fishing in Washington is about $854 million[4] per year. And commercial fisheries in Washington generate $146 million[5] per year in economic benefits. It would be a mistake to conclude that the marginal benefits directly associated with the state's proposal indicates that no economic benefits accrue from these uses. The data show this is not true.

5.3 Interruptible Water Rights

The proposed rule provides a process for holders of existing water rights issued subject to the 1980 instream flow rule (Chapter 173-563 WAC) to obtain a drought permit that would not be interrupted during future low flow periods. The proposed rule describes the criteria, requirements, and procedures related to application for, granting, and use of drought permits for interruptible water rights.

Droughts are a natural part of the climate cycle. In the last century, Washington has had a number of drought episodes, including the severe droughts that occurred in 1977 and 2001, and several that lasted for more than a single season, such as the dry periods between 1928-32 and 1992-94. According to records, a drought year for the Columbia mainstem occurs about once in every 26 years, on average.

In a drought year, if an alternative water supply cannot be found, both the interruptible water right holders and the Washington economy would experience losses. If an interruptible water right holder can find alternative water sources, they may not suffer reduced production. The state's economy, however, may suffer losses on a net basis as water uses are retired to provide water for interruptible water right holders, or if public funding is used to buy replacement water for these interruptible water users.

In a dry year requiring interruption of supply for the interruptible water right holders in agriculture, part or all of their revenue will be foregone due to the lack of water. For

[4] 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, Washington.
[5] 2003 Washington State Data Book.

annual crops, the total loss is limited to the lost revenue that would have come from the harvest.[6] However, many of the crops grown along the Columbia River are perennial crops, such as orchards and vineyards. The loss of water for more than 12 weeks in the middle of the irrigation season, or similar loss of water in the fall to prepare for over-wintering, could result in widespread loss of these assets resulting in a larger scale total impact.

Irrigation water is also used to cool fruit trees during hot summer days. Overhead sprinkling lowers temperature and helps to prevent scalding and sunburn that significantly degrade the value of fruit. For apples, pears and other tree fruits harvested in the fall, the lack of this kind of water supply can result in no crop or a crop so small that it is not economical to harvest.

The potential for a sizable capital loss has reportedly affected the ability of some holders of interruptible water right holders to secure bank loans using property equity as repayment collateral. As a result, production, incomes, and property values have suffered.

During the 2001 drought, Ecology temporarily reduced the mandated minimum stream flows in the Columbia River basin between April and September as allowed under the instream flow rule. Growers agreed to reduce their water use to seventy percent of normal levels. At the same time the legislature provided public funding to buy or lease water to offset the effects of water usage during periods in which use would otherwise be curtailed. Without these actions, about 300 farmers with interruptible water rights would have lost the ability to draw water out of the Columbia River during the growing season. In 2001, as a result of state funding, the irrigators benefited from the release of 33,322 acre feet of water by the Federal Columbia River Power System. The water was provided to offset the continued use of water for their crops during the driest part of the summer. This action prevented the loss of millions of dollars in crops. However, the state's strategy to avoid interruption of water use required complicated and coordinated actions by multiple parties. This approach is not considered a reliable safeguard against future dry years.

Climate models suggest that future warming of the Northwest's climate the will alter Columbia River basin hydrology significantly. The models estimate that overall annual precipitation will remain approximately the same and perhaps even increase slightly. But more of that precipitation will be in the form of rain rather than snow. This reduction in snowfall, combined with an earlier melting of the snowpack, will result in a quite different runoff pattern. Annual discharge may not change appreciably, but the timing of that discharge will probably change considerably. Natural winter and spring streamflows will be higher and peak flows will occur earlier in the year. Conversely, natural streamflows in the summer months, will undoubtedly be lower. The net effect of these changes will be less water available naturally in the summer months when it is needed for irrigation and other uses.

[6] This loss may be offset for the farmer to the extent that variable costs can be reduced. However, if those resources are then unemployed, the offset may be a cost to the owners of the resource.

Under the proposed rule, the interruptible water right holders can apply for a drought permit, which would, in effect, convert an existing right into an uninterruptible water right. As a result, the risk of a loss associated with a drought will be significantly reduced and the proposed rule would result in a social benefit.

The proposed rule does not force interruptible water right holders to acquire a drought permit. The proposed rule only provides an opportunity to reduce the risk of losses resulting from a drought. If a water right holder believes the drought permit will provide gains, they can apply for one. If they do not believe it will provide gains, then they don't have to apply.

If holders of interruptible water rights do not want to apply for a drought permit, then everything stays consistent with the baseline scenario, and the net social benefit of the proposed rule would be zero.

In Appendix D, this analysis estimates that the total social benefit for the 20-year period under this hypothetical scenario is about $ 5.76 million.

5.4 Water Rights Issued In 2003

The proposed rule would provide certainty for recently issued permits, including the Quad-Cities permit, and for other rights issued in 2003 currently subject to court processes.

The Quad-Cities currently have a water right that requires mitigation of water use. They have received 10 cubic feet per second (cfs) of mitigation water from the state and will need to obtain mitigation, in six year increments, to offset additional water use.

In the case of the Quad Cities permit, the net benefits that result will depend on the cost of the mitigation water that is obtained. As a relatively small purchaser, the Quad Cities may experience higher acquisition costs than they would under a state program. If so, the Quad-Cities may expect to obtain a net benefit from the proposed rule. If the Quad-cities can obtain water for less than the cost of water under the proposed state program, then there would be no cost or benefit from the proposed rule.

In Appendix E, this analysis estimates that the total benefit for the 20-year period under this hypothetical scenario is about $ 7.02 million.

5.5 New Agricultural Water Rights[7]

The proposed rule is intended to meet the water needs of additional agricultural development along the river. The proposed rule will significantly increase the certainty

[7] Includes applications pending since 1991, and future applications.

that new water rights can be issued if the state can obtain a sufficient water supply to support allocations.

From Appendix F, if 728 KAF water is available for the 20-year period and 486 KAF is available for out of stream uses, the water available for issuing new water rights will be 361 KAF and if water rights are issued evenly over time[8], the resulting social benefits would be $ 182.55 million.

The calculated benefit is based on an assumption of constant prices for agricultural commodities over time and is subject to forecast error. As with any forecast of the future, there is risk that the actual outcomes experienced by producers may vary from the estimates used to calculate benefits in this report. If, for example, developing countries continue to employ a strategy designed to exploit cheap labor resources to grow high value crops at the expense of Washington producers, then the price assumptions in the University of Washington economic study and this analysis would be too high. On the other hand, if state growers continue to improve the efficiency and productivity of their operations, and if world markets for fruit and vegetables continue to grow as predicted by some, then the stable price assumption may be reasonable. The risks associated with the price estimates in this report are inherent in any forecasting exercise.

5.6 New Municipal and Industrial Water Rights

Various researchers have agreed that the average water value for municipal and industrial (M&I) water is higher than the average value for other uses. The University of Washington economic report pointed out that:

> *In any given year, the value per AF for M&I water will be greater than or equal to the value per AF for irrigation water.*
>
> *Grouping Washington, Oregon, and Idaho and collectively calling this area the Pacific Northwest because of the similarities in land geography and water availability gives a range for M&I water values of $0/AF to $452/AF.*

The National Academy of Sciences report concluded that the value of municipal water is between $34--$403/AF, and the value of industrial water is between $10-$1248/AF.

Other research[9] has found similar results:

> *It is estimated here that the municipal/industrial sectors' net economic value of water is equal to or greater than $86.00/acre-ft.*

[8] If we assume more water right will be issued early in the 20 year period, the benefit will be more because the water can participate the production process earlier and produce value earlier.

[9] D. Olson (2003). Economic Analysis Methodology Illustration and Review: Estimating the Value of Water for Key Resource Sectors from the Mainstem Columbia River.

Relying on these and other sources,[10] this analysis assumes that the M&I water value ranges between $65 per acre-foot and $452 per acre-foot is reasonable. The mean/median[11] value of $255.50 per acre-foot is used in calculations.

According to the estimate made in the University of Washington report, a total of 91,752 acre-feet of water will be needed for municipal and industrial uses during the 20-year life of the rule. Some of this water is for Quad-Cities, which belongs to the 2003 new water rights. By assuming that the Quad-Cities will add water uses in a linear pattern over time, one can derive an estimate that the new M&I water will be about 53.1 KAF and the total benefit in the 20-year period will be $ 105.58 million[12].

5.7 Hydropower

The Columbia River and its tributaries power one of the world's largest hydroelectric systems. Under the proposed rule, additional water for instream uses will increase the potential production of hydroelectric power at all dams along the Columbia mainstem in the summer months. However, generating capacity can be expected to be lost in other periods as refill of existing reservoirs or increased diversions occur. It is also the case that water added to the system as a result of conservation or acquisition programs would result in net generation benefits to the system. Detailed system level power analyses are required to assess the potential effects of Columbia River Initiative actions on the regional power system.

As stated previously, the costs and benefits of specific project actions will be assessed on a project basis as they are developed. In the case of hydropower generation, analysis required to determine the potential revenue effects of an action can only take place once more detailed, project level data is available.

In addition, the Federal Columbia River Power System benefits the 4-state region, including the states of Washington, Oregon, Idaho, and Montana. As a result, it is

[10] Department of Ecology estimates based on data from sample cities, 2004. There is a marked difference between the values for different levels of water quality and quantity for commercial and industrial uses. Some commercial and industrial users use water directly from the river or from wells. Some use municipal supply. The value of the marginal product may simply equal the pumping costs. Alternatively it may equal the municipal price of the water. The following indicates the size of the potential range. The marginal value of "excess" water (water above 600 gallons per day) sold by the East Wenatchee Water District is approximately $500 per acre foot per year ($1.15/100cf). [http://www.ewwd.org/home.htm downloaded 11/4/04.] This includes processing and delivery costs. One recent transfer cost the party over $1,000 per acre foot for a permanent right. A new aquifer storage recharge system can range from $35 to $1,200 depending on the year and the frequency of use. In one city, water rates are $800 per acre foot for wholesale, which does not count distribution costs. The price for retail is $1,200 for commercial uses and $1,400 for residential users. The gap between these costs indicates the potential magnitude of the cost of treatment and distribution. The latter value would be the approximate value to the commerce and industry using the water.

[11] The use of mean value can be justified by central limit theorem if the sample size is large enough.

[12] See Appendix K.

difficult to quantify the net social costs and benefits that would accrue directly to Washington as a result of adopting the proposed rule.

5.8 Fish and Wildlife, Recreation

The proposed rule would require that one third of the water acquired under the program be held in trust and remain in the river, resulting in potential benefits to fish and wildlife. The report of the National Academy of Sciences clearly stated that salmon populations were likely to be exposed to increasing risks to their survival from a number of sources outside the control of the state. The report identified several risk factors including, new water allocations by other jurisdictions, and increasing water temperatures among others.

As a result of the scientific conclusions, the state has proposed to fully offset water use in Washington, and to make a modest contribution to reducing the risk facing salmon in the future, by adding water to current stream flows. Because the water acquired as a result of the proposed rule will increase the amount of water in the river, both flows and temperatures can be expected to be modestly augmented. It is reasonable to conclude that the program will moderate the risks to a healthy watershed, fish and wildlife in the future.

Likewise recreational benefits may also accrue. Because the proposed rule and state policy would result in additional water in the Columbia River in the summer months the risk that salmon-related recreation will further degrade over time is reduced, resulting in a net social benefit to the state.

As discussed above, recreational and commercial fisheries dependent upon the Columbia River have significant economic benefits to the state of Washington.

5.9 Flood Control and Navigation

According to the University of Washington economic report:

> *The new CRI water diversions are not expected to have any perceptible effects on flood control activities, because the diversions will occur mostly during May – August, while flood control is a major factor in river operations only during the late winter and early spring high run-off period. Shallow draft river navigation (barging) occurs in the reservoir system from Bonneville dam to the Tri-cities area, and up the Snake River as far as Lewiston, Idaho. Barging is not expected to be significantly affected because reservoir levels are maintained to exceed levels necessary for lockage at dams even in dry years. Deep-draft navigation in the lower Columbia River below Bonneville dam is not expected to be affected by the new diversions, because the minimum flow needed to maintain the shipping channel depth (70 kcfs) will not be jeopardized.…..*

Additionally, the proposed rule and program would result in additional flow in summer months, further protecting navigation.

5.10 Conclusion

Given the assumptions and data indicated above, if 728 KAF new water is available over the next 20 years and 486 KAF is available for out-of-stream uses, the total probable benefit to be generated from the proposed rule is expect to be approximately $ 300.91 million, not including un-quantified environmental and cultural benefits.

6. COSTS

6.1 Overview

Using standard cost benefit methodologies the costs associated with the proposed rule would be opportunity costs, which are measured by the highest costs of foregone alternative uses. Because of the difficulty determining opportunity costs, the estimated costs to the state to obtain water[13] are substituted for opportunity costs in this analysis.

Under the state's proposal, water to implement the management program for the mainstem of the Columbia River would be acquired through the implementation of water conservation programs and projects as authorized and funded by the legislature.

More specifically, sources of water may include:

a. Implementation of water conservation measures.
b. Implementation of BMPs. Saved water is returned to the state by water right holders, who choose to implement best management practices (BMPs) under the proposed rule;
c. The development of new or expanded multipurpose water storage projects;
d. Changes in conveyance of water and management of existing storage projects;
e. Acquisition of existing water rights, in part or whole, through purchase or donation; and,
f. Water contributed to the Columbia River as a result of the implementation of local watershed plans in tributaries to the Columbia River.

The cost of water obtained through conservation or Best Management Practices (BMPs) consists mainly of the capital investment and operating and maintenance costs required to improve water use efficiency[14].

[13] In a limited market such as this the price of acquisition may be higher than the opportunity cost of the water.

[14] Although conservation or BMPs may have some impacts on return flows or on ground water aquifers due to a small increase in total consumptive use, the impacts are expected to be small. Since the rule requires one third of the water acquired through conservation to be permanently dedicated to instream purposes, the net impact should be more water in the river.

The costs of developing new, off-mainstem storage are not estimated in this report. Instead, they will be analyzed as projects are proposed because the storage methods, storage capacity, and site selection, among other factors, will significantly affect costs. The literature indicates that the unit costs of small new storage projects may be too high to generate net social benefits. For large new storage projects, the literature[15] shows that the unit costs can be low enough to generate net social benefits. Changes in management of existing storage projects sometimes can result in significant net social benefits depending on the circumstances of a particular project.

6.2 Cost of Acquiring Water

The total amount of water acquisitions associated with the proposed rule has been estimated by Ecology at 728,000 acre feet. The cost estimates provided below present a range of potential costs and resources based on current information available to the agency. The true cost of developing or acquiring water may be more or less than the estimates provided in this report. While there are many methods to obtain water for reallocation under the proposed rule, this analysis focuses on the more cost-effective alternatives.

	Estimated Quantity Available	Lower Annual Cost ($/year)	High Annual Cost ($/year)	Initial Capital Investment
Canada	380,000	3.45	10.45	3,000,000
Potholes	200,000	4.67	4.67	15,000,000
Conservation	50,000	17.43	17.43	
Acquisition	50,000	37.58	37.58	
BOR, Grand Coulee	100,000	13.00	40.00	
Odessa	50,000	16.40	43.40	3,000,000

**The unit cost includes the initial investment by a discount rate of 6% to perpetual, see Appendix K.*

The costs of securing an agreement for the summer release of water with the Canadian government is estimated to be one-third of the power benefits that would result from the increased flow. The range of values represents the uncertainty associated with this value.

The cost of modifying the Potholes Reservoir, associated works, and acquisition of flood easements on private lands has been estimated by the Bureau of Reclamation to be between $10 million and $20 million. The midpoint of this range was chosen for illustrative purposes.

[15] Ecology Publication Number 01-11-002, Table 4, Water Storage Task Force Report to the Legislature, Construction Cost for Selected New Reservoirs in Washington and Other States; and, Plan Formulation Summary, Report to: Regional Director, Bureau of Reclamation, Pacific NW Region, & Director State of Washington Department of Ecology, January 1986.

The costs associated with acquiring water through conservation investments are known to Ecology as a result of experience administering a conservation acquisition program. The cost estimate reflects the average cost of acquiring water through this mechanism.

The cost estimates for the release of water from Grand Coulee Dam and the development of the Odessa Aquifer are based upon the assessments that the Bureau of Reclamation currently charges agricultural and municipal/industrial water users, respectively. The actual costs of facilitating this release may be more or less.

Based upon these data, the weighted average cost[16] acquire water to implement the state's program is $16.66 per acre-foot. Based upon this assumption an estimate of the total cost of acquiring water in support of the Columbia River Initiative is in the range of $94.35 million[17].

Exploring the potential for new off-channel, multipurpose storage is an important part of the Columbia River Initiative. However, due to the lead times involved, new storage capacity is not considered a feasible source of water during the first 20 years under the proposed rule.

6.3 Cost of BMPs or Mitigation

6.3.1 Interruptible Water Rights

If an interruptible water right holder chooses to apply for a drought permit under the proposed rule, they can do so under one of three program options:

- Implementing best management practices (BMPs)
- Agreeing to make mitigation payments
- Developing a mitigation proposal

The applicant can select any of these options in exchange for access to water acquired by the state. Each of these options results in costs to applicants.

If interruptible water right holders act according to economic principles, they will choose the lowest cost option available to them, and, by extension, will only apply for a drought permit if they can reasonably expect to benefit as a result.

This analysis assumes that the maximum cost that water right holders will incur is equivalent to entering agreements with the state to make mitigation payments. We believe this approach is a conservative assumption because the mitigation payments option establishes an upper limit on the costs that water right holders will be willing to incur to receive a drought permit. Either of the other options are unlikely to be chosen if the result is higher costs than provided for in a mitigation payment agreement.

[16] Use upper bound if available.
[17] See Appendix K.

If the interruptible water right holders choose the mitigation payment option, this analysis does not include the cost of these payments as a social costs because, by definition, it is a wealth transfer. Instead the analysis counts only the cost of acquiring the water itself.

Although the mitigation payment is a wealth transfer, the BMP and mitigation proposal options are likely result in capital investment and operating costs, which use resources that can be devoted to alternative uses. Neither of these costs are wealth transfers and, as a result, should be counted as social costs in this analysis. Given that the mitigation payment is an upper limit on these social costs, the maximum social cost is estimated at $4.65 million[18].

6.3.2 Water Rights Issued in 2003

Consistent with the previous section, mitigation payments that are made in exchange for access to water acquired by the state will not result in social costs to Washington because they are transfer payments.

6.3.3 New Water Rights

New water right applicants may choose one of two mitigation options— either a mitigation proposal or mitigation payments. Mitigation proposals have been incorporated as part of many recent water right applications. Further the 2003 new water rights include mitigation. Therefore, mitigation is treated as baseline and no new societal costs are calculated for an ongoing baseline activity. Again, the mitigation payment is a transfer payment that is not included in calculations of social costs.

6.4 Administrative Costs

The Department of Ecology estimates that an additional $1.44 million per biennium (approximately$720,000 per year) will be required to administer the program created by the proposed rule. Ecology expects these costs to be reviewed by the Office of Financial Management and considered for inclusion in the Governor's budget request for the Columbia River Initiative.

6.5 Unquantified Costs

It is important to consider other potential costs associated with implementing the proposed rule. For example, there may be social costs that result from the drawdown of Lake Roosevelt behind Grand Coulee Dam. These costs may result from losses of resident fish and related fisheries, impacts upon tribal resources associated with Lake

[18] See Appendix K.

Roosevelt, and recreational impacts. However, sufficient information is not available for this analysis to quantify these costs.

7. CONCLUSION

In summary, this analysis indicates that the probable benefit of the proposed rule is greater than the probable cost. This conclusion is based on the scenario that:

The state will obtain 728 KAF water from various sources, and issue 486 KAF water for out-of-stream beneficial use.

The quantified probable net benefit of the proposed rule is expected to be $ 187.51 million under the assumptions developed in this report, in addition to un-quantified environmental and cultural benefits and costs that may result. It is important to consider that forecasting risk may result in lower or higher actual benefits to the state.

Summary of Costs and Benefits Resulting from the Proposed Columbia River Water Resources Management Rule (dollars in millions)

Benefits	
Interruptible Water Rights	$5.76
2003 New Water Rights	7.02
Future New Water Rights	182.55
Municipal and Industrial	105.58
Environmental Benefits	>0
Hydropower	>0
Recreation	>0
Flood control and navigation	>0
Subtotal Benefits	***$ 300.91***
Costs	
State Cost	$94.35
BMP Cost	4.65
Administrative Costs	14.40
Other Costs	>0
Subtotal Costs	***$113.40***
Net Social Benefits	**$ 187.51**

8. BREAKEVEN ANALYSIS

The accuracy of any cost-benefit analysis depends on the accuracy of the data that are used to predict future costs and benefits. Forecasting is always an exercise in uncertainty. One mechanism for dealing with this uncertainty is to use a breakeven analysis to test the sensitivity of the estimated costs and benefits.

The breakeven point of the cost of water is $ 49.76/AF[19]. This means that if the cost of water acquired by the state is more than $ 49.76/AF, the proposed rule will generate net social costs to Washington. Because this breakeven point is based on the quantitative cost and benefit without considering the qualitative cost and benefit, it is likely that the actual breakeven point would be above this point.

Because of its high value, water provided to municipal and industrial uses will always generate net social benefits. The benefits to hydropower, recreation, navigation and various other sectors are byproducts of the proposed rule, and almost have no social costs associated with them. As such, particular attention has been paid to the effect of the proposed rule on the agricultural sector.

It can be safely concluded that water used to mitigate for drought permits will generate net social benefits since the potential losses associated with a drought are large and the water for the drought permit is only used once in about 26 years[20].

For the water rights issued in 2003 (Quad-Cities and others) the water rights have already been issued, and the benefits only come from the costs of obtaining mitigation water. If the state can acquire mitigation water for less than the Quad-Cities can, then this action will generate net social benefit.

For the water issued as new water rights, if the water value is greater than the water cost of acquiring water by the state, net social benefits will be created. However, if the value of water is less than the mitigation payments established in the proposed rule, then irrigators would have no reason to rely upon the water in the long run. Thus, the social cost per acre foot can not be more than $16.66/AF (the state cost of acquiring water) - $10.00/AF (the mitigation payment) =$6.66/AF.

The worst case for the proposed rule is that the value of water lies between $10/AF and $16.66/AF in the long run. The possibility of this occurring is remote. Even in the worst case, the net social benefits from other beneficial uses, particularly municipal and industrial uses, would more than offset the possible losses resulting from cost-based decisions not to apply for new water rights.

[19] See Appendix K.

[20] Global warming may cause more frequently drought, but we don't expect this will be very significant in the time horizon used in this analysis.

APPENDIX A: DATA REGARDING SELECTED CROP YIELD AND REAL REVENUE PER ACRE FOR WASHINGTON STATE[21]

Figure 1. Total Yield of Washington Apples (1919-2002)

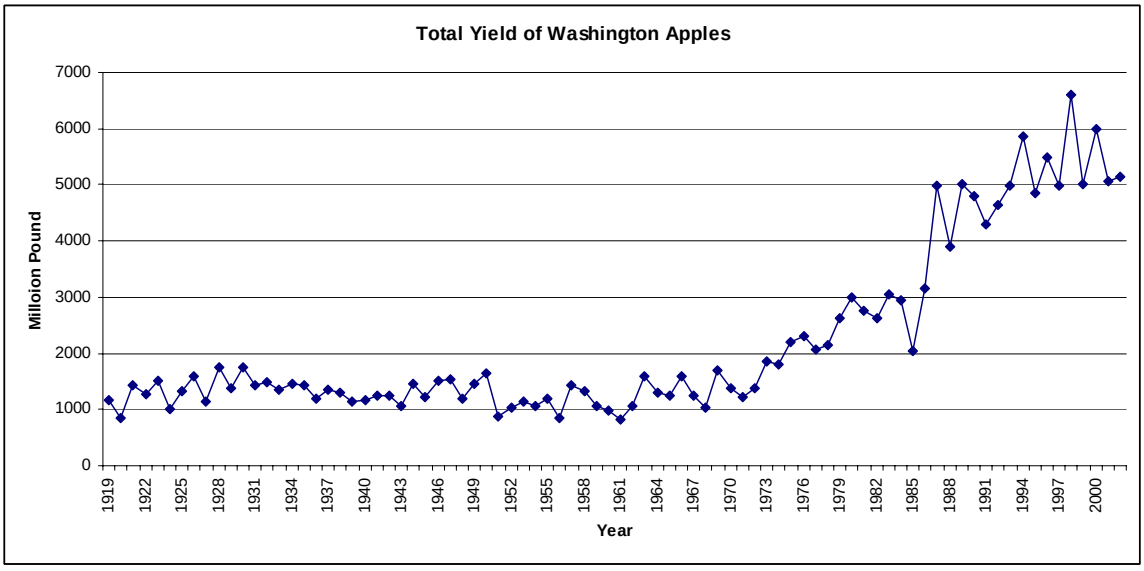
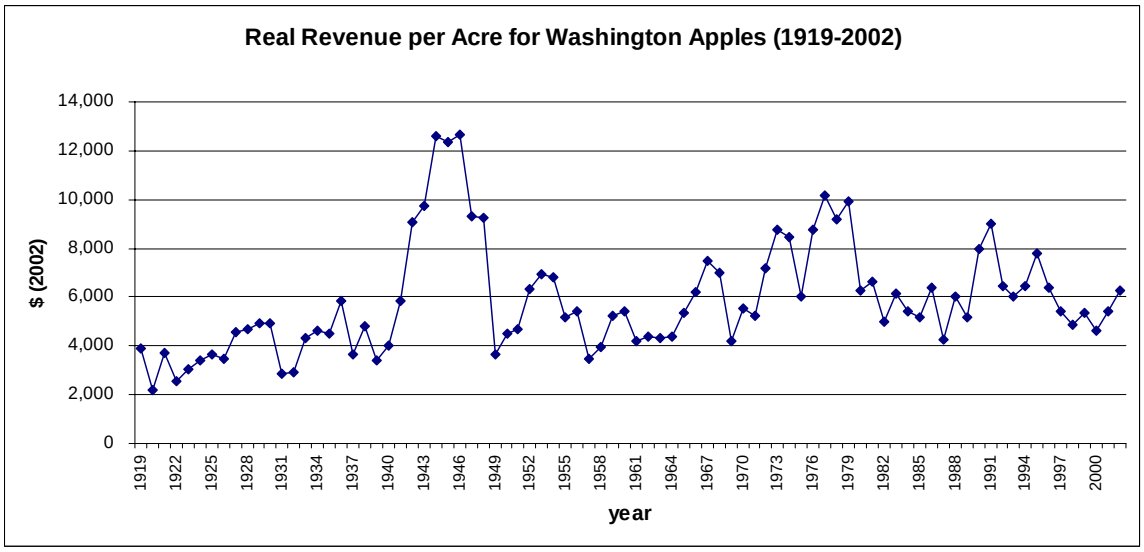


Figure 2. Real Revenue per Acre for Washington Apples (1919-2002)



[21] Data sources: Consumer Price Index, 1913-2004. Federal Reserve Bank of Minneapolis. Crops prices: USDA- National Agricultural Statistics Service

Figure 3. Total Yield of Washington Grapes (1919-2002)

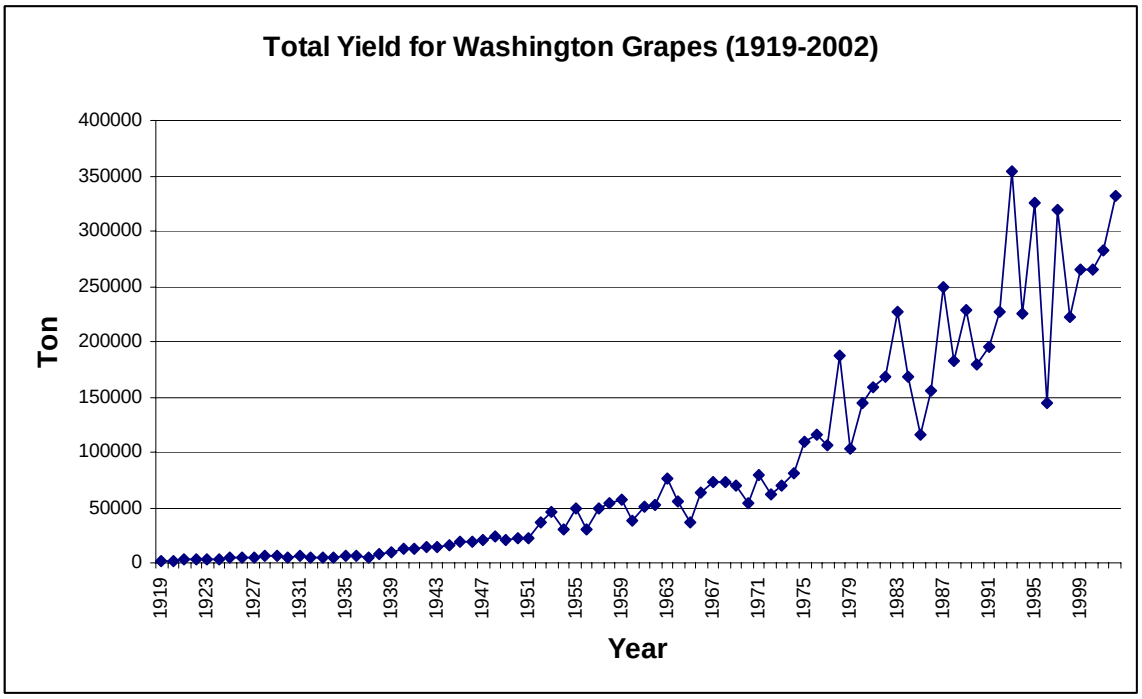


Figure 4. Real Revenue per Acre for Washington Grapes (1924-2002)

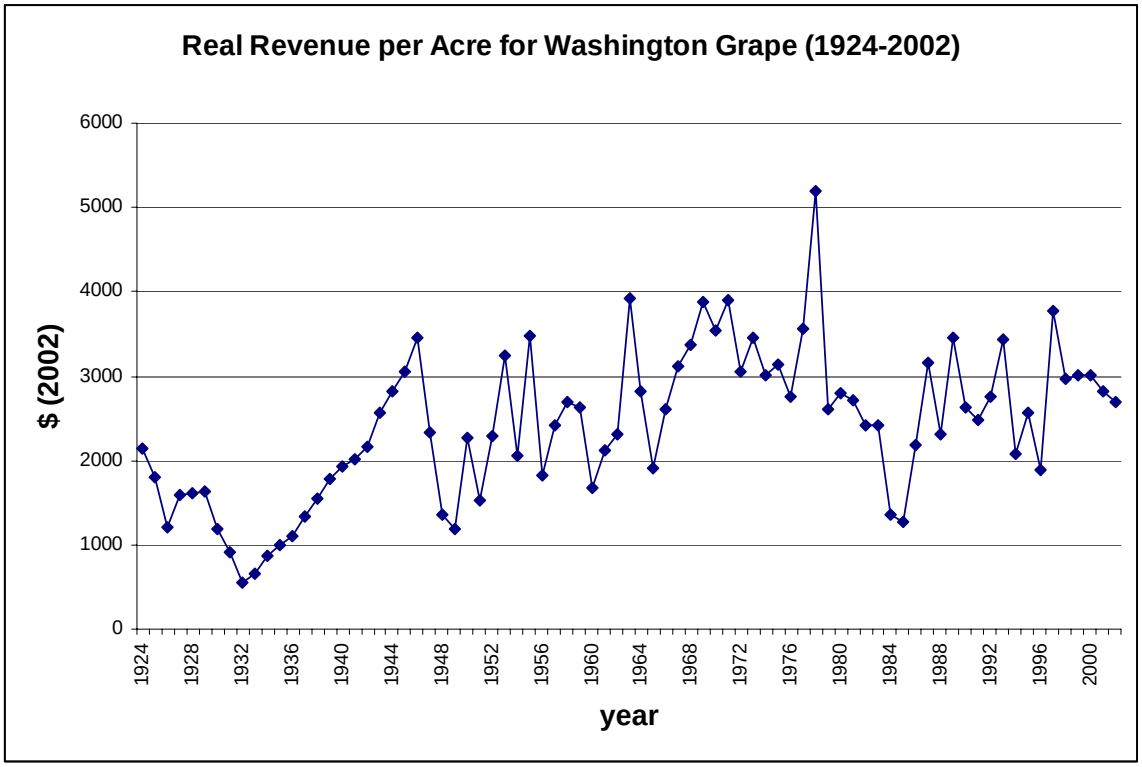


Figure 5. Total Yield of Washington Potatoes (1933-2002)

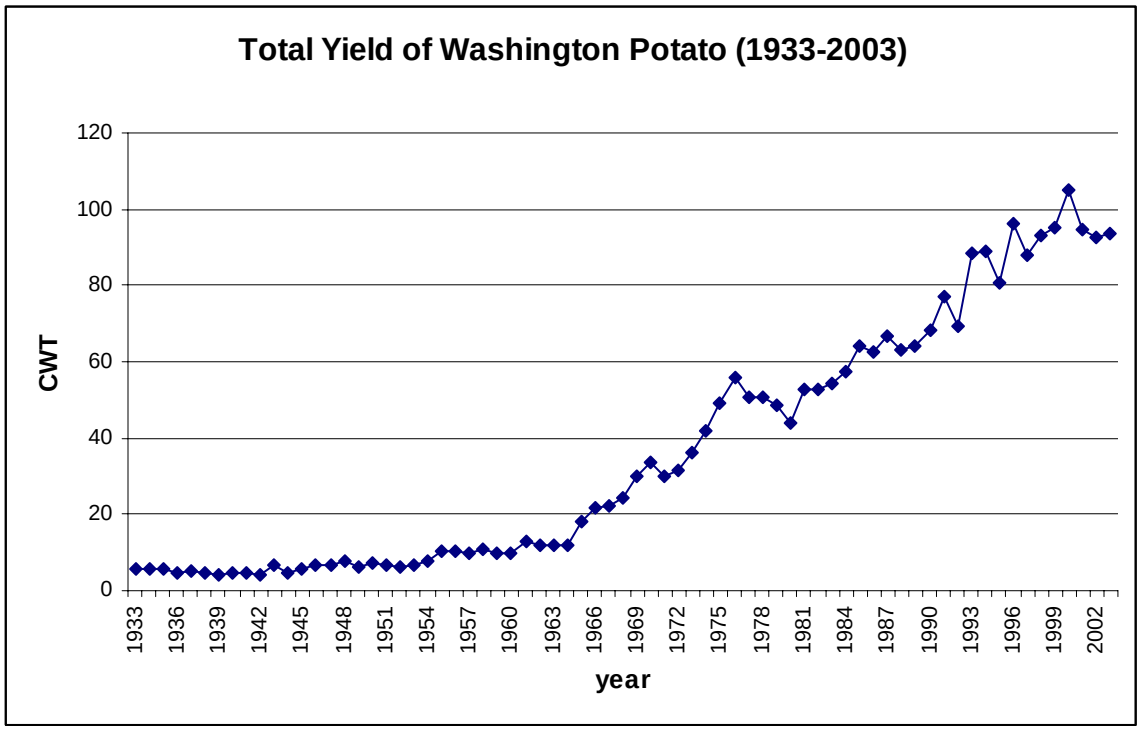
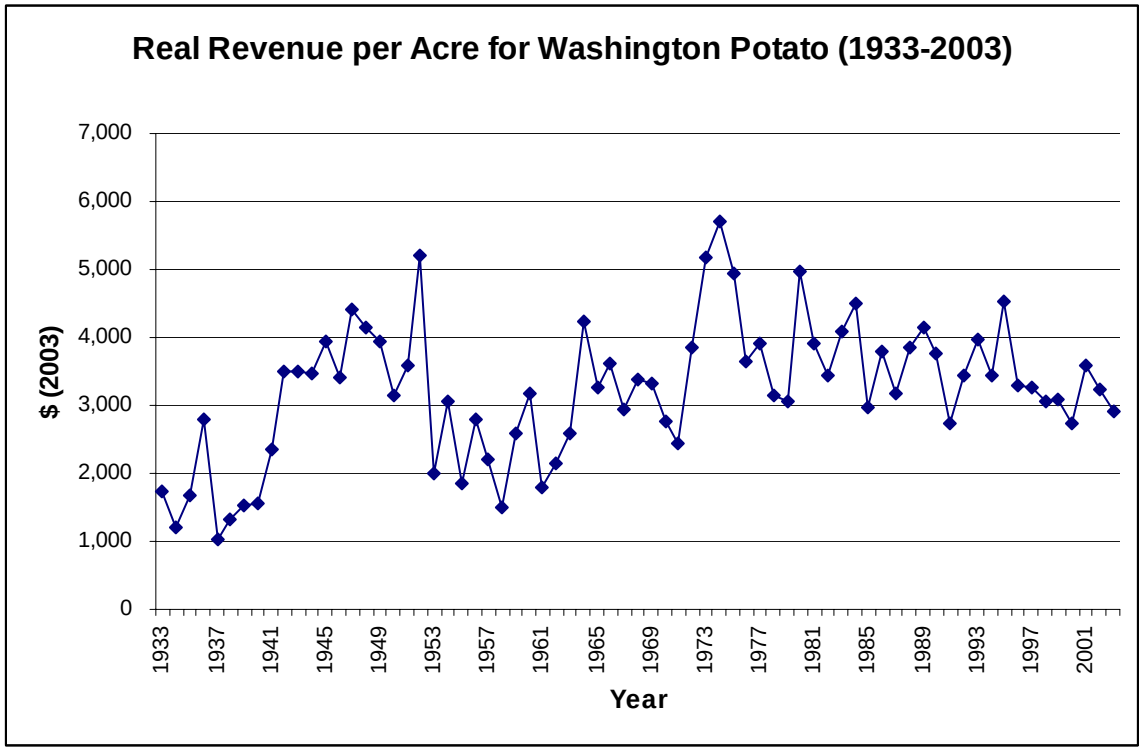


Figure 6. Real Revenue per Acre for Washington Apples (1933-2002)



APPENDIX B: METHODOLOGY AND SECONDARY IMPACTS

As previously stated, secondary benefits were not used to calculate net social benefits. The following citations are provided to explain the reasoning behind this approach.

1. 6-b-3 of Circular No. A-94 Revised (Transmittal Memo No. 64) Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs. The Office of Management and Budget:

Multiplier Effects*. Generally, analyses should treat resources as if they were likely to be fully employed. Employment or output multipliers that purport to measure the secondary effects of government expenditures on employment and output should not be included in measured social benefits or costs.*

2. Guidelines for Preparing Economic Analyses, EPA, 2000. EPA 240-R-00-003:

In general, the social cost of a policy can be measured exclusively by changes that occur in the markets directly targeted by a policy, as long as significant net changes in social welfare are not generated in indirectly affected markets. If price changes in other markets generate both gainers and losers among the producers and consumers, then they may offset each other in a social cost analysis as transfers.

3. OMB Circular A-94 (U.S. Office of management and Budget 1992)

… 4) Real economic value rather than transfer payments should be included in the net benefit calculation. Transfer payments may be considered and discussed in terms of distributional aspects.

4. Economic Analysis Primer—Benefit-Cost Analysis. U.S. Department of Transportation - Federal Highway Administration:

Indirect impacts of a transportation project could include local changes in employment or land use. The value of indirect effects is not *additional to that of direct effects measured in BCA; rather, indirect effects are a restatement or transfer to other parties of the value of direct effects. Indirect economic effects are measured using economic impact analysis and not BCA*

5. Nas, Tevfik F. 1996, Cost-Benefit Analysis, Theory and Application, [658.1554 NAS 1996, state library] Sage publications:

a. [Real output] effects not only need to be properly identified and account for, but also must be distinguished from redistributive outcomes to avoid over- or understatement of costs and benefits. (p67, Nas, 1996)

b. Pecuniary effects. Note that real external effects should not be confused with pecuniary external effects. Pecuniary external effects, also referred to as secondary effects, are gains and losses to producers who either employ or produce inputs and outputs that are identical or closely

related to those used or produced by the project under consideration. For example, the implementation of a project may result in an increase in the price of an input that the project uses, a decrease in the price of the project output, a reduction in the price of substitute goods, and/or an increase in the price of complementary goods, as the competitive market moves to a new equilibrium, each one of these outcomes is likely to generate gains and losses in related industries (McKean 1958, 135-50). When all such gains and losses are considered, the net change in welfare could turn out to be zero, or the change may be so significant that it could make a difference in project ranking. Should these and all other likely spillovers in both backwardly and inwardly linked industries be considered in cost-benefit comparisons?

Before providing a definitive answer, consider the following examples. Increased traffic volume generated by a highway project is likely to produce spillover effects by changing the sales volume of auto-related goods, such as oil, gas, parts, and tires; increasing the demand for construction workers and materials; and possibly diverting traffic and roadside business from other highways in the vicinity. In the case of an agro-industrial project, industries supplying equipment and raw materials for the project will flourish, and investment in the infrastructure of the area will increase. A public housing project will also produce secondary effects in an area by increasing public health services for the elderly and needy and increasing the demand for construction materials. Are these legitimate secondary benefits that need to be added to the primary benefits, or should they be excluded from cost-benefit comparisons?

The consensus in the literature is that they should be avoided[22]*. As already stated, such effects result mainly from relative price changes in private markets and involve only redistributive effects. There may be no net social gains when all secondary losses and gains from a project are combined. A flow of secondary gains stemming from a project might be offset by a flow of losses elsewhere in the economy. For example, the increased sales and earnings in the computer industry resulting from a reorganization project that uses a computerized system will be offset by reduced salaries for noncomputer clerical workers and earnings in the substitute industries. So, to avoid double counting, these effects must be excluded from cost-benefit computations.*

Even when the flow of gains exceeds the flow of losses, which is likely to be the case in a growing economy, the difference should not enter into cost-benefit comparisons. Again, the consensus view is that the price mechanism in a properly functioning market will take care of such additional benefits. In a competitive environment, because the demand for the project-related goods will be derived from the demand conditions existing in both primary and secondary markets, their prices will probably reflect all likely secondary effects on these markets as well. However, if there is no market for the project output, then the analyst may assess a value for it and make sure that double counting is avoided. For example, increased wages and salaries of drug enforcement personnel are a transfer of the surplus generated by a drug control project and therefore should not be added to the total benefit expected from this project. As another example, the increased profits of roadside restaurants along a newly built highway are a transfer of consumer surplus generated from the highway that should have been included at the time the project was under evaluation. In both example, the surplus generated is estimated by the analyst, and all related secondary benefits should be part of the estimate.

Nevertheless, secondary effects need to be studied carefully because the decision of whether to include them in the analysis depends on the nature of the specific economic environment where the project is under consideration. For example, if such effects represent repercussions on the profitability of the proposed project, then they must be considered (McKean 1958, 141-3). Also, if the profits of the producers displaced by a project cannot be recovered because of the fact that they may be nontransferable (that is , no offsetting gains in consumer or producer surplus can be

[22] For a detailed discussion of real versus pecuniary effects, see McKean (1958, Caps. 8-9), Prest and Turvey (1965), Weisbrod (1968a), and Mishan (1988, Chap. 12).

created in other markets), then it is reasonable to deduct such losses from the project's benefits. Finally, it should be noted that pecuniary considerations may be significant when the public policy analysis involves distributional questions. (p83-p84, Nas, 1996)

6. Fuguitt, Diana., Wilcox, Shanton., 1999, Cost-Benefit Analysis for Public Sector Decision Makers. [352.33 Fuguitt 1999, State library] Quorum Books

One group's gain is another group's loss, with no change in social welfare. Such pecuniary effects should therefore not be included as a benefit or cost.
The same can be said for changes in the prices of substitutes or complements. These too are pecuniary effects. For example, suppose in our dam example, the electricity price does not indeed fall and some consumers switch to using lower-priced electricity in place of other substitutes, such as natural gas. The price of natural gas might then fall, and the remaining natural gas consumers would pay lower prices. It can be argued that the latter consumers obtain a benefit. True enough, yet the natural gas firms would receive lower prices. Once again, the price change caused by the dam represents a redistribution of income away from firms to their consumers, not a net change in social welfare. Thus, pecuniary effects should not be included in a cost-benefit analysis. (p169, Fuguitt, 1999)

7. Boardman, Anthony., Greenberg, David., Vining, Aidan., Weimer, David. 1996. Cost-Benefit Analysis: Concept and Practice, [658.1554 cost, 1996, State library] Prentice Hall.

a. We can and indeed should ignore effects in undistorted secondary markets, regardless of whether or not there are price changes, if we are measuring benefits in the primary market using empirically measured demand schedules that do not hold prices in the secondary markets constant. (p87, Boardman, 1996)

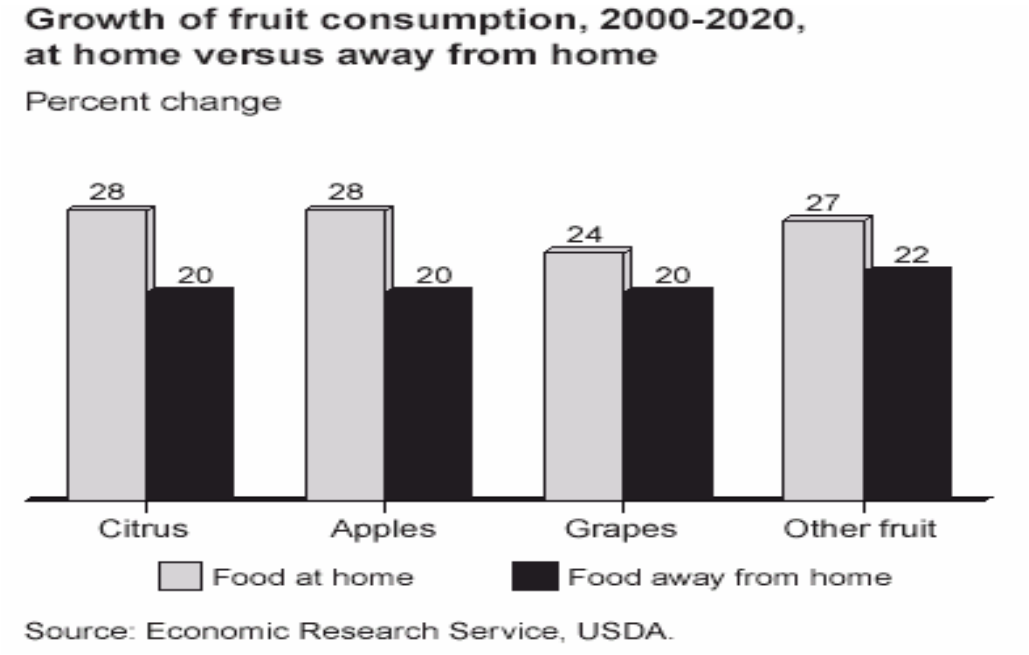
b. Price changes in most secondary markets are likely to be small. Most goods are neither strong complements nor strong substitutes. Hence, large price changes in the primary markets are usually necessary to produce noticeable demand shifts in the secondary markets. Thus, even when secondary markets are distorted, ignoring these markets may result in little bias to CBA. (p87, Boardman, 1996)

APPENDIX C: UNITED STATES DEPARTMENT OF AGRICULTURE (USDA) RESEARCH ON AGRICULTURAL DEMAND

Food and Agricultural Commodity Consumption in the United States: Looking Ahead to 2020. By Biing-Hwan Lin, Jayachandran N. Variyam, Jane Allshouse, and John Cromartie, Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No. 820.

Due to an anticipated population growth of 50 million between 2000 and 2020 in the United States, total consumption of all 22 commodities is predicted to rise, even though per capita consumption of many commodities is predicted to fall. The results suggest that fruits will lead all commodities in terms of growth in both total and per capita consumption. Certain vegetables, such as lettuce and tomatoes, are predicted to grow substantially, while per capita potato consumption (fried and other) is predicted to decline, slowing down the growth in total U.S. potato consumption. Increases in meat, poultry, and fish consumption vary. Per capita fish and poultry consumption is predicted to rise while beef, pork, and other meat per capita consumption is predicted to fall. Per capita consumption of milk and cheese is predicted to fall, while per capita consumption of yogurt and eggs is predicted to rise. The consumption of nuts and seeds and grains is also predicted to rise over the next two decades.

(F)or the beginning and ending years—2000 and 2020. Fruits are predicted to lead all commodities in the growth of the at-home market, with a 24-28 percent growth (fig. 8), followed by a 23-percent increase for fish, 22 percent for lettuce, and 21 percent for nuts and seeds as well as other vegetables. Fried potatoes consumed at home are predicted to grow the least, by only 5 percent. Fried potatoes consumed away from home are also predicted to experience slow growth—10 percent over the next two decades.



Food Expenditures by U.S. Households: Looking Ahead to 2020. By Noel Blisard, Jayachandran N. Variyam, and John Cromartie, Economic Research Service, U.S. Department of Agriculture, Agricultural Economic Report No. 821.

By 2020, the effects of demographic changes and income growth will increase per capita spending on food 7.1 percent. Income growth alone, which will effect spending increases of almost 10 percent on away-from-home foods and 3 percent on at-home foods, will raise per capita food spending about 6 percent. Expansion of the Nation's population will drive growth in food demand and, combined with rising incomes and other demographic changes, is projected to boost total U.S. food spending 26.3 percent. On a national level, the slow but steady growth of the population will result in little variation among expenditure growth levels of individual food groups. The largest projected increase is for fruits, up 27.5 percent, while the smallest is for both beef and beverages, up 21.1 percent.

U.S. Food Sector Linked to Global Consumers
Anita Regmi and Greg Pompelli
Food Review, Spring 2002
Economic Research Service, USDA

Global Consumers Important to Future U.S. Food Sector Growth
Global per capita GDP grew about 2.6 percent in the 1990s, with low- and middle-income countries registering higher growth rates of 4 percent and 3 percent, respectively, and high-income countries registering growth rates of 2 percent. Increased purchasing power among consumers in developing countries has been accompanied by faster rates of population growth in these countries compared with developed countries, leading to greater demand for food. Although developed countries also experienced income growth and slight increases in population, growth in food demand in these countries is smaller relative to developing countries.

In addition to increased demand for food, developing countries will also undergo changes in the composition of food demanded. The developing countries, which accounted for about one-half of the world's urban population of 1 billion in 1960, are expected to account for over four-fifths of the world's urban population of almost 5 billion in 2020. Along with urbanization, income levels, education, lifestyles, and food availability are expected to change in developing countries, resulting in greater demand for variety and labor-saving food products.

Therefore, future economic prospects for the U.S. food sector will be partially tied to income gains in low- and middle-income nations. Consumers in high-income nations around the world will continue to purchase U.S. goods, but the changes in consumption patterns will largely reflect consumer preferences for quality and laborsaving products, and not increased consumption. Rising incomes in low- and middle-income countries, however, will generate increased demand for many food products and create significant market opportunities for the U.S. food sector because even small dietary changes will aggregate into large changes in demand, as each change will be multiplied by millions of people. International competition and macroeconomic events may cloud the gains, but

changing global consumer demand will be an important component of future gains in the U.S. food sector.

Foreign markets will be one source of future sales growth for the U.S. food sector. Hence, global macroeconomic conditions are important along with domestic market conditions. Changes in global macroeconomic factors, such as economic growth rates of U.S. trading partners and currency exchange rate levels, can overshadow increased global consumer interest in U.S. food products and ingredients. Slowing economic growth can temper demand for food, especially high-value products, and U.S. products become more expensive in other countries when the U.S. dollar appreciates against local currencies.

Just as increased global growth generates marketing opportunities for U.S. exports, slower global growth reduces trade opportunities and changes the composition of U.S. agricultural exports.

Relative exchange rates also affect trade opportunities because exchange rates affect prices faced by importers. Thus, a strong (appreciating) dollar can reduce the ability of the U.S. food sector to compete in global markets and increase opportunities for competitors.

Agricultural Workforce in Washington State 2003
Washington State Employment Security Department

The past five years present a picture of little growth in Washington agriculture in terms of acres planted, employment, sales, or income. Apples, which remain overwhelmingly the most important product in Washington, typify this stagnation. Although prices for apples were high in 2003, intense competition in apples is forcing Washington apple growers to explore new varieties and planting techniques, as well as, to improve quality on the grocery store shelf. Opportunities remain but a trend of strong growth is unlikely.

New technology and boutique products present potential growth opportunities for some. The main new technology offering wide scale promise is bio-engineered food. Continued concerns about the health and safety of bio-engineered food, though, is likely to ensure that only large producers will be able to implement and profit from new varieties. This cost advantage for large producers for bio-engineered food may be partially offset by the advantage of very small producers in organic, fresh produce for local markets.

The ability to export effectively to foreign markets will be a determining factor in the health of Washington agriculture into the future. The export of agricultural products accounts for about a third of total income earned in agriculture nationally. Intense competition from China in some agricultural commodities will be partially offset by incredible opportunities for growth as the Chinese middle class grows.

Rising costs of doing business will confront Washington agricultural producers at the same time that they are facing increased domestic and foreign competition. Farmers will need to deal with a broad array of challenges simultaneously. While agriculture will continue to be an important industry in Washington, the emphasis will move towards lowering costs, increasing productivity, and improving crop varieties and away from ordinary measures of growth. This shift in emphasis will have long-term implications for farm viability and employee earnings.

APPENDIX D: BENEFITS TO INTERRUPTIBLE WATER RIGHT HOLDERS

As discussed in section 5.3, the proposed rule would provide interruptible water right holders an opportunity to obtain a drought permit, therefore making water available to them during periods in which their water use would otherwise be curtailed. The existing interruptible water rights are about 172 KAF[23], and almost all of them are used for irrigating 45,850 acres of farmland[24]. The interruptible water rights are applied to the following crop mix[25]:

Crops	CFS	AF/Y	AUTHORIZED ACRES	Ir Acres
Vegetable	4%	5%	4%	4%
Orchard	84%	81%	79%	79%
Pasture	9%	10%	12%	12%
Field Crop	2%	3%	3%	3%
Potatoes	1%	1%	1%	1%

About 80 percent of the acreage (approximately 36,200 acres) is in orchards, a perennial high value crops.

For the purposes of this analysis a hypothetical scenario is used to estimate the potential losses for the interruptible water right holders. The assumptions in this hypothetical scenario are based on professional best judgment and are intended to be conservative. For a given year, it is assumed that:

- The probability of this year being a drought year is 1/26;
- The probability that an interruptible water right holder cannot obtain replacement water in a drought year is 1/3; [26] and,
- The probability that an interruptible water right holder can obtain water in a drought year is 2/3.

This set of assumptions converts to an average annual probability as follows: The probability that an interruptible water right holder would have to curtail withdrawals of water from the Columbia River is (1/3×1/26) = 1/78. The probability that an interruptible water right holder will experience a drought and successfully get replacement water is 2/78.

In any drought year that the interruptible water right holder cannot obtain water, it can be conservatively assumed that no fruit trees will die due to the drought. However, the revenue of the orchard would almost certainly be affected. It is assumed that 50% of the

[23] KAF = 1000 acre feet.
[24] It underestimates the benefit considering the higher value of M&I uses.
[25] This is summarized from available data.
[26] This probability quantifies the risk associated with the interruptible water rights. The number is tenuous. However, it cannot be zero, which means no risk. As we know, irrigators believe 'interruptible' is a big risk to them, and to our best judgment, this number will underestimate their feeling of risk.

crop would be lost due to a lack of water. For annual crops, it is also assumed 50% of the revenue would be lost. The University of Washington report estimates revenue per irrigated acre and crop is:

	Hay	Orchards	Vegetables	Potatoes	Wheat
Revenue	$877	$5,485	$1,408	$3,122	$334
Water usage/acre	2.69	2.52	1.75	2.07	1.82

The cost is a function of average probable losses and is estimated by adding the cost for both outcomes using the assumptions above for any future year.

- The expected unit loss for the interruptible water right holders from a drought would be the weighted average water value per acre-foot, which is $11.61/AF[27].

- On the other hand, there is a chance that interruptible water right holders could obtain water through state action to reduce minimum instream flows and/or provide funding to acquire replacement water. The state spent $1 million in year 2001 to buy water for the interruptible water right holders. To calculate the costs associated with the state buying water to supplement the assumed 2/3 in this analysis. This is equivalent to $0.77/AF[28].

The value of the water is either the loss associated for reduced crop production due to less irrigation water or the cost of replacing the water. Summing the weighted average water value per acre-foot ($11.61 AF) and the cost to the state of buying water ($.77 AF) is $ 12.38. This amount estimates agricultural and state losses. This does not quantify expected environmental and fish losses.

Two possible factors could be used to adjust this $ 12.38 figure but they were not incorporated.

- If there is reduced harvest or planting costs, these revenues could partially offset the loss. Irrigators, like other businesses, cannot avoid fixed costs. Variable costs may be avoided in part. However, this analysis will assume no costs can be avoided since we have already assumed only part of the crop revenue is foregone. If crops are harvested there is no savings.

- Reducing the minimum instream flow through the state purchases described above adversely impacts water temperature and water quality. Although Ecology cannot quantify the impacts to fish, recreation, navigation, etc, various sources have shown that they will be adversely impacted. This is a social cost that would be avoided by the program.

[27] See Appendix K.
[28] (2/3)× (1/26) × ($1,000,000/33,322AF) = $0.77/AF .

The proposed rule will reduce the losses that were quantified above to zero, and Washington will obtain an estimated $ 12.38 per acre-foot per year in terms of agricultural producer surplus as a result of adopting the rule, not including un-quantified environmental and fish benefits.

In order to calculate the total benefit of the Columbia mainstem rule proposal, this analysis assumes that 33 KAF of water will be issued as drought permit, and will be issued evenly over the five-year period from 2005 to 2009. The total benefit for the 20-year period under this hypothetical scenario is about $5.76 million, not including the un-quantified environmental benefit.

APPENDIX E: BENEFITS TO THE HOLDERS OF WATER RIGHTS ISSUED IN 2003

To quantify the probable social benefit, this analysis assumes that the Quad-Cities would be able to obtain the mitigation water from Bureau of Reclamation for $40 per acre-foot without the adoption of the state rule. This is the price the Bureau of Reclamation charges when providing M&I water to other users.

The Bureau of Reclamation has stated that it has the legal authority and physical capacity to make this water available. Further, the volume of water available from the Bureau is covered under an existing consultation with the National Oceanic and Atmospheric Administration – Fisheries agency as required under the Endangered Species Act. No new consultation would need to occur to make this water available.

For the Quad-cities, assuming the state can acquire water at an average cost of $16.66/AF (discussed in section 6), then the savings attributed to the mitigation water would be $40/AF -$16.66/AF = $23.34/AF. If the same amount of mitigation water is provided each year, the total benefit from the proposed rule will be $ 7.02 million[29] over the 20-year period.

[29] See Appendix K.

APPENDIX F: BENEFITS TO APPLICANTS FOR NEW WATER RIGHTS

Before evaluating the social benefits of new water rights, it is necessary to understand two important points:

1. The market price approach vs. the farm budget approach

   In its analysis, the University of Washington uses an enterprise budget approach to calculate the value of water. It estimates total farm income and expense for a crop to estimate the expected profitability of this crop in a particular location[30]. The farm budget approach establishes a value for new water rights by assuming the economic profit is zero if the water value is taken into account. This is the primary basis for the estimates of value developed in this analysis.

   Others believe that the market price approach would be a better way to estimate the value of water. This latter approach is also used as a reference in this analysis, although a lack of stable data regarding water transactions along the Columbia mainstem limits its reliability.

2. The impacts of the new water rights

   The UW report expressed concerns about the market condition of specialty crops, which could include orchards, vegetables, potatoes, and some of the crops in the other (high value) crop group. The data available indicate that for some specialty crops, in the short run, a higher yield may result in a lower price. However, historical price trends indicate that this is probably just a temporary impact, with long run prices stable around equilibrium despite increasing yields.

   Figure 1 to Figure 6 in Appendix A are the basis for this conclusion. Together they show:

   - Real revenue per acre (or the price) of specialty crops varies by as much as 20 percent within any given year;
   - The real revenue per acre consistently trends toward the long run equilibrium price. This appears to be a stationary process;[31]
   - Increasing production over time has not resulted in lower real revenue on a per acre basis; and,
   - Two of the three specialty crops, apples and grapes, show an increase in real revenue per acre over a long time horizon.

   It is important to note that the issuance of new water rights in the quantities contemplated by the Columbia River Initiative will not dramatically increase production above existing levels.

[30] In the UW economic report, the enterprise budgets are mainly from WSU extension program. All crop phases are included in these enterprise budgets.

[31] a mean reverting process, it means that the relative violated in the short run but holds in the long run.

The state plans to obtain 728 KAF of new water, with 486 KAF being made available for out-of-stream use. About 33 KAF will be used for issuing drought permits, about 38 KAF[32] for Quad-Cities, and about 53 KAF[33] for M&I uses. Only 360 KAF are left for irrigating about 65 thousand acres of farmland [34]. This is approximately 5.3% of the existing 1,422,797 acres[35] of irrigated farmland in counties along the Columbia mainstem. As a result, the increased production resulting from the new water rights should not be large.

Although the amount of land used for agricultural purposes in Washington has declined for decades, the amount of irrigated farmland has been increasing over time. The total amount of farmland in counties along the Columbia mainstem declined from 10,057,502 acres[36] in 1997 to 9,745,411 acres in 2002. During the same period, however, irrigated farmland increased from 1,384,722 acres to 1,422,797 acres, a 2.75% increase in 5 years. For high value crops, land for orchards (not including Okanogan County) and vegetables has increased more than 10% in these same counties.

On the demand side, several studies done by the United States Department of Agriculture (USDA) (citations are listed in Appendix C) show the demand for agricultural products, both for the United States and the world, is expected to significantly increase over the next 20 years.

It is important to note that increasing national and international demand for agricultural products may not benefit Washington producers. Various factors can worsen the outlook for agricultural producers residing in Washington. Some of these factors include the macroeconomic health and government policies of both the U.S. and other countries, exchange rates, Washington farm productivity relative to competitors, and international trade barriers.

In conclusion, this analysis uses constant real revenue per acre to quantify the total benefits in the 20 years. The reasons for this choice are:

1. The real revenue per acre has reasons to go both up and down. However, most of the reasons have existed for a long time and the historical data didn't show the trend. Therefore, this analysis has no reason to believe the historical trend will change;

2. The discussion of section 8 has investigated the worst scenario;

[32] 80% of the water right issued to Quad-cities in 2003.
[33] See section 5.6
[34] This acreage number is assumed to be the same water use (AF) per acre irrigated farm land as the 2003 new agricultural water rights.
[35] 2002 Census of Agriculture. Without Yakima and Skamania county.
[36] All data in this paragraph are from 2002 Census of Agriculture.

Thus the social benefit of issuing new water rights consists primarily of producer surplus. The change of consumer surplus will be small if the price change is small.[37] Therefore Ecology does not quantify any consumer surplus gained. This makes the analysis slightly more conservative. The value of the products of the water to the direct water user, the agricultural producer, is the only thing counted.

This cost benefit analysis adopts the result of the UW report for the value of water in agricultural applications -- $65 per acre-foot (assuming a mitigation payment of $10/AF) as the permanent real water value trend, and treats the sum of the temporary effect as zero for the 20-year time horizon. This UW number is derived from a crop mix similar to current crop mix, and is likely to underestimate the true water value than to overestimate it considering the crop mix of the interruptible water rights dominated by orchards (the highest use water use value).

In developing this analysis, other research was identified that evaluated the value of water in agricultural applications. In its report, the NAS concluded:

> *The range of the value of water in agricultural applications in the western U.S. generally varies from values as low as $3 per acre-foot for low-value crops under conditions of adequate water supplies (no water stress), to values in excess of $200 per acre-foot for high-value crops. Median values for most mixed cropping systems in the Pacific Northwest suggest that the agricultural value is in the $40 to $80 per acre-foot range.*

One researcher that investigated water market transactions[38] said:

> *If the market value for water is assumed to be about $500 to $1,000 per acre-ft. (capital value), then estimates of annualized values can be made given various assumptions about cost of capital interest/discount rates and the time period for commercial lending. For example, using a capital value range of $500-600, with a 7-8% interest/discount rate range,[39] covering a conventional farm loan period of 15 years, the estimated value range would be between $54.90/acre-ft. to $116.83/acre-ft. A mid-point estimate would be about $86.00/acre-ft.*

The NAS report also introduced other research[40] completed in 1989, which concluded that the marginal values for a representative Columbia River basin crop mixture were inferred to be $46 per acre-foot when water was tightly restricted, but valued at only a few dollars per acre-foot when water available for the crop was not restricted.

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[37] For given small elasticity.

[38] Olson, D (2003). Economic Analysis Methodology Illustration and Review: Estimating the Value of Water for Key Resource Sectors from the Mainstem Columbia River.

[39] Nominal or market interest/discount rates are used here to be equivalent to the market-based values reflected by the other resource sectors. Real or social time preferences rates could be used, but for comparison purposes, other sector values would need to be expressed in similar terms.

[40] Bernardo, D. J., and N. K. Whittlesey. 1989. Factor Demand in Irrigated Agriculture Under Conditions of Restricted Water Supplies. USDA, Economic Research Service, Technical Bulletin 1765.

On average, the higher end value of water is more reasonable for the Columbia River. As a result, the analysis used a value for water value of $65 per acre-foot used as a constant real value for the 20-year period since it falls well within the range provided by other research.

If 728 KAF water is available for the 20-year period and 486 KAF is available for out of stream uses, and if it is issued in an evenly time pattern[41], the total benefit is estimated at $ 182.55 million.[42]

It is important to restate an observation regarding forecast risk included in the body of the analysis. Economists recognize that the potential for error in forecasts increases the further into the future a forecast extends. There is also significant risk inherent in estimating the future price of agricultural commodities. Foreign competition, depressed markets resulting from protectionism, or long-term structural problems in U.S. agriculture that will make it uncompetitive with other producers will tend to depress the prices or production quantity that could be supported by Washington growers. On the other hand, improved efficiency and productivity, sophisticated marketing, and healthy international markets would tend to support increasing prices and production over time. The reader needs to keep these risks in mind as the contents of the analysis are evaluated.

[41] If we assume more water right will be issued early in the 20 year period, the benefit will be more because the water can participate the production process earlier and produce value earlier.
[42] See Appendix K.

Appendix G: SETTLEMENT AGREEMENT BETWEEN THE STATE OF WASHINGTON AND THE COLUMBIA SNAKE RIVER IRRIGATORS ASSOCIATION, et al.

Appendix K: FORMULAE FOR CALCULATION

K.1 Interruptible Water Rights

K.1.1

Weighted Average Water Value per Acre-foot: $u = (\sum_{i=1}^{5} p_i V_i / w_i) / p_d \, p_{nr} \, p_l$

Where: i = 1, 2, 3, 4, 5. expresses 5 different crops: hay, orchards, vegetables, potatoes, and wheat.

For each crop

p_i the percentage of total acres in each type crop.
x Vi the value in use of each type of crop
$\div w_i$ water usage/acre.

Sum the values for all the crops and then divide by:

p_d probability of a certain year to be a drought year.
x p_{nr} probability of loss to irrigators in a drought year.
x p_l: Percentage of loss to the expected revenue in a drought year with losses.

K.1.2

The total quantified benefit = $\sum_{i=1}^{5} \frac{uiQ}{5(1+d)^{i-1}} + \sum_{i=6}^{20} \frac{uQ}{(1+d)^{i-1}}$.

The first half of the equation covers years 1 through 5 and the second half of the equation covers years 6 through 20.

Explaining iQ/5 and Q:
Each year a certain amount of water right is given out. This equation assumes that the water is given out evenly over a 5 year period for the first 5 years and that the value therefore increases. Thus each year 1/5 of the water is given out. Q is the total quantity of water issued to drought permit. Thus in year 1 there is 1/5 Q given out and in year 2 there is 2/5 Q given out, etc. Finally in the 5th year the entire Q is given out.

Explaining u:
The unit of value u is the Weighted Average Water Value per Acre-foot that was calculated in K.1.1. This is multiplied by the amount of water for every year.

Explaining discounting with d:
Then the value for each year is summed but first it is discounted. Discounting gives the value today of water that arrives in later years. d is the discount rate, an

interest rate that compounds every year. Thus by year 20 the interest has compounded 19 times. So each year is divided by 1+d compounded or multiplied time itself. d is the real rate of interest at which people are willing to trade off consumption today against consumption next year.

K.2 New Water Rights Issued in 2003

Benefit: $\sum_{i=1}^{20} \frac{i(C_Q - C_S)Q}{50(1+d)^{i-1}}$

The gain to the state for water going to the Quad-cities is the cost to the city of substitute water minus the cost to the state of mitigation water. The state program is expected to have economies of scale and be able to obtain water more cheaply. Thus C_Q is the per acre foot cost of Quad-cities if they obtain the mitigation water by themselves. This is the gain to the cities. C_S is the corresponding state cost. Q is the quantity of mitigating water that the state may provide to the cities in 50 years. See the explanation of discounting using 1+d above.

K.3 New Water Rights

Benefit: $\sum_{i=1}^{20} \frac{iQv}{20(1+d)^{i-1}}$

This formula estimates the value of new water to agriculture. The formula assumes that the total quantity (Q) of new water to agriculture will be given out evenly over the 20 year life of the program. Thus the amount of water provided in any given year is iQ/20 where i is the number of years the program has been going.

The amount of water is multiplied by v, the change in the value of agricultural product per acre-foot of water.

See the explanation of discounting using 1+d above.

K.4 Municipal and Industrial (M&I) Water Rights

The new M&I water includes the Quad-cities water right, which must be handled separately. Thus the Q for new M&I water is: Quw – 20Qquad-cities/50. Quw is the forecast in the UW report, and Qquad-cities is the 2003 water right issued to Quad-Cities.

Benefit: Benefit: $\sum_{i=1}^{20} \frac{ivQ}{20(1+d)^{i-1}}$

This formula estimates the value of new water to municipal and industrial uses. The formula assumes that the total quantity (Q) of new water to municipal and industrial water users will be given out evenly over the 20 year life of the program. Thus the amount of water provided in any given year is iQ/20 where i is the number of years the program has been going.

The amount of water is multiplied by **v**, the average value of water. In the best circumstances for industry this would reflect the change in the value of industrial product per acre-foot of water and for municipalities it would reflect the value all the users place on the water.

See the explanation of discounting using 1+d above.

K.5 Cost of BMP or Mitigation

This analysis evaluates the potential cost of best management practices or mitigation.

$$\text{Max cost} = \sum_{i=1}^{5} \frac{iPQ}{5(1+d)^{i-1}} + \sum_{i=6}^{20} \frac{PQ}{(1+d)^{i-1}}.$$

The payment for mitigation water is used as a proxy for the cost of the best management practices and water management shifts that generate the water. P is average value of the mitigation payment.

The equation assumes that all the water will be aquired in the first 5 years. Thus the amount of water paid for is iQ/5 for the first 5 years.

Q is the quantity of water issued to drought permits, and d is the discount rate.

K.6 Converting One Time Total Capital Cost (C) to Annual per Acre-foot Cost (A)

$$C = Q \sum_{i=1}^{\infty} \frac{A}{(1+d)^{i-1}}$$

$$A = Cd/Q(1+d)$$

Where, Q is the total water quantity by certain capital investment.

K.7 Breakeven Analysis

The breakeven point for water value per year is: (C –Bi –Bq-Bm&I)/μQn

Where: C, is the total cost discussed in in section 7
Bi is the benefit to the interruptible water rights
Bq is the benefit to the 2003 new water rights
Bm&I is the benefit to M&I new water rights
Qn is the quantity of new water rights.

Breakeven point for water cost per year = (B –Cm-Ca)/μQw
Where: B is the total benefit in section 7, Cm is the cost of BMP or mitigation, Ca is the administration cost, Qw is the amount of water that the state can acquire.

$$\mu = \sum_{i=1}^{20} \frac{i}{20(1+d)^{i-1}}$$